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Remedial Action Report OU 5-05 Stationary Low-Power Reactor No. 1 and OU 6-01 Boiling Water Reactor Experiment-I Burial Grounds Engineered Barriers

Idaho National Engineering Laboratory

U.S. Department of Energy • Idaho Operations Office

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Remedial Action Report
OU 5-05 Stationary Low-Power Reactor No. 1 and OU 6-01 Boiling Water Reactor Experiment-I Burial Grounds Engineered Barriers

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SIGNATURE PAGE

Chris M. Hiaring

Chris M. Hiaring
LMITCO Project Manager

9-10-97
Date

Jon Rothermel

Joseph S. Rothermel
RD/RA Project Manager

9/10/97
Date

ABSTRACT

This report describes the Remedial Design/Remedial Action for the Stationary Low-Power Reactor No. 1 burial grounds and Boiling Water Reactor Experiment-I burial site at the Idaho National Engineering and Environmental Laboratory. The purpose of the remedial action was to eliminate or reduce potential exposure to radionuclide-contaminated debris and soil. To achieve this, radionuclide-contaminated surface soils adjacent to the burial sites were excavated and placed on the burial ground areas. Then barriers engineered of native materials were constructed over the burial sites. Remediation also included construction of chain-link fences around the areas, installation of warning signs and placement of granite monuments at the fence corners.

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ACRONYMS

AEC	Atomic Energy Commission
ANL	Argonne National Laboratory
ARA	Auxiliary Reactor Area
ARAR	applicable or relevant and appropriate requirements
BORAX-I	Boiling Water Reactor Experiment-I
Cat	Caterpillar
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CE	construction engineer
CFA	Central Facilities Area
CID	construction interface document
COC	contaminant of concern
dBA	decibel A-weighted
DEQ	Division of Environmental Quality
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
DQO	data quality objectives
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
HSP	Health and Safety Plan
ICPP	Idaho Chemical Processing Plant
IDHW	Idaho Department of Health and Welfare
IDW	investigation-derived waste
IH	industrial hygiene/hygienist
INEEL	Idaho National Engineering and Environmental Laboratory

L&V	limitation and validation
LMITCO	Lockheed Martin Idaho Technologies Company
M&O	management and operations
O&M	operation and maintenance
OU	operable unit
Parsons	Parsons Infrastructure and Technology Group, Inc.
PPE	personal protective equipment
QA	quality assurance
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
RADCON	Radiological Control
RAO	remedial action objective
RCT	radiological control technician
RD/RA	remedial design/remedial action
ROD	Record of Decision
RPD	relative percent difference
RWMC	Radioactive Waste Management Complex
SDG	Sample Delivery Group
SL-1	Stationary Low-Power Reactor No. 1
STF	Security Training Facility
SWPPP	Storm Water Pollution Prevention Plan
TBC	to be considered
TPR	technical procedure
USGS	United States Geological Survey
VDS	Vendor Data Schedule
WROC	Waste Reduction Operations Complex

Remedial Action Report
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1. INTRODUCTION

1.1 Overview

In accordance with the Idaho National Engineering and Environmental Laboratory (INEEL) Federal Facility Agreement and Consent Order, the U.S. Department of Energy (DOE) submits the following Remedial Action Report to document the remediation of the Stationary Low-Power Reactor No. 1 (SL-1) and the Boiling Water Reactor Experiment-I (BORAX-I) burial grounds within Operable Units (OUs) 5-05 and 6-01. Both sites are radioactive subsurface disposal areas located at the INEEL. The purpose of this report is to describe how the remediation goals set forth in the Record of Decision (ROD) for these sites were met, describe the work performed, discuss any modifications to the remedial action, and to document the final status of the project.

Based upon consideration of the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), detailed analysis, and public comment; the Department of Energy Idaho Operations Office (DOE-ID), the Environmental Protection Agency (EPA), and the Idaho Department of Health and Welfare (IDHW) selected containment by capping with an engineered long-term barrier as the remedial action at both SL-1 and BORAX-I burial grounds. The barrier systems were constructed to provide:

- Shielding from penetrating radiation
- A barrier to inhibit biotic intrusion at SL-1 over the pits and trenches
- An inadvertent human intrusion barrier at both SL-1 and BORAX-I
- Longevity through the predominant use of native geologic materials
- Low maintenance requirements
- Containment of the contaminated surface soils which could pose a total excess cancer risk greater than one in 10,000 for a subsistence farmer occupying the land 100 years in the future at SL-1 and BORAX-I (the protective covers are required to be effective for approximately 400 years at SL-1 and 320 years at BORAX-I).

The barrier systems are combined with institutional controls, long-term maintenance inspections, and periodic review to ensure that the remedy achieves the remedial action objectives (RAOs) set forth in the ROD and Section 8 of this document.

The engineered barrier at the SL-1 burial grounds has two main components: (1) a biotic barrier which consists of a gravel, cobble, gravel sandwich; and (2) a human intrusion barrier which consists of large angular boulders (rip-rap). The BORAX-I engineered barrier consists of one component, an inadvertent human intrusion barrier consisting of rip-rap.

Results of sampling done prior to and during the remedial action indicated that surface soils within the 183 × 92 m (600 × 300 ft) SL-1 burial ground exclusion fence were found to be contaminated above the 16.7 pCi/g Cs-137 ROD action levels for SL-1. Approximately 1,840 m^3 (2,407 yd^3) of contaminated soil was excavated from these areas comprising 4,452 m^2 (1.1 acres). The soil was excavated and consolidated between Pit 2 and Trench 1 prior to placement of the engineered barrier (see Figure 1-1). The SL-1 engineered barrier was installed in four layers: (1) 10.2 cm (4 in.) pea gravel, (2) 30.5 cm (12 in.) cobble, (3) 15.2 cm (6 in.) pea gravel, and (4) 61 cm (24 in.) rip-rap.

The BORAX-I soils which were found to be contaminated above the 16.7 pCi/g Cs-137, 13.2 pCi/g U-235, and 10.8 pCi/g Sr-90 ROD action levels, as determined by sample analysis results, were also excavated and consolidated. These areas were within the OU 6-01 site definition boundary but outside the original exclusion chain link fence. Approximately 560 m^3 (733 yd^3) of radionuclide-contaminated soils from five areas comprising 1,820 m^2 (0.45 acres) was excavated and consolidated over the 37 × 37 m (120 × 120 ft) reactor burial ground prior to construction of the engineered barrier. The BORAX-I barrier was installed in two layers: (1) compacted consolidated soils, and (2) rip-rap.

Chain-link fences with gates and "Keep Out" signs were erected around both the SL-1 and the BORAX-I sites. Engraved granite monuments, with universal warning symbols were placed outside the chain-link fence at each site.

1.2 Background

1.2.1 SL-1 Accident

The SL-1 was a small nuclear power plant designed for the military by Argonne National Laboratory (ANL) to generate electric power and space heat for remote arctic installations. The reactor was operated by ANL from August 1958 until February 5, 1959, when Combustion Engineering, Inc., commenced operations. Combustion Engineering operated SL-1 as a test, demonstration, and training facility. When the SL-1 was shut down for the 1960 Christmas holiday, it had produced 931.5 MWd of power, and approximately 40% of the core life had been expended (Atomic Energy Commission [AEC] 1961).

On the evening of January 3, 1961, SL-1 achieved a prompt-critical reaction, producing a steam explosion that resulted in fatal injuries to the three reactor operators. A central control rod was raised which resulted in rapid formation of steam in the core blowing off the pressure vessel head. The reactor vessel and interior of the reactor building were severely damaged and highly contaminated as a result of the accident.

Although the reactor building was not designed to provide containment in the event of a nuclear excursion, very little of the particulate fission products that left the vessel actually escaped outside of the building at the time of the accident (AEC 1962).

An investigation ensued and the reactor core, reactor fuel, pressure vessel, a section of the fan room floor, and all other parts of the reactor that were important to the investigation of the accident were removed to the Hot Shop at Test Area North for study. Following the investigation, the fuel was reprocessed at the Idaho Chemical Processing Plant (ICPP), and the other materials were disposed in the Radioactive Waste Management Complex (RWMC). To minimize radiation exposure to the public and site workers, that would result from transporting contaminated debris from SL-1 to the RWMC over 26 km (16 mi) of public highway, a burial ground was constructed northeast of the original site of the reactor. Original site cleanup took about 18 months. The entire reactor building, contaminated

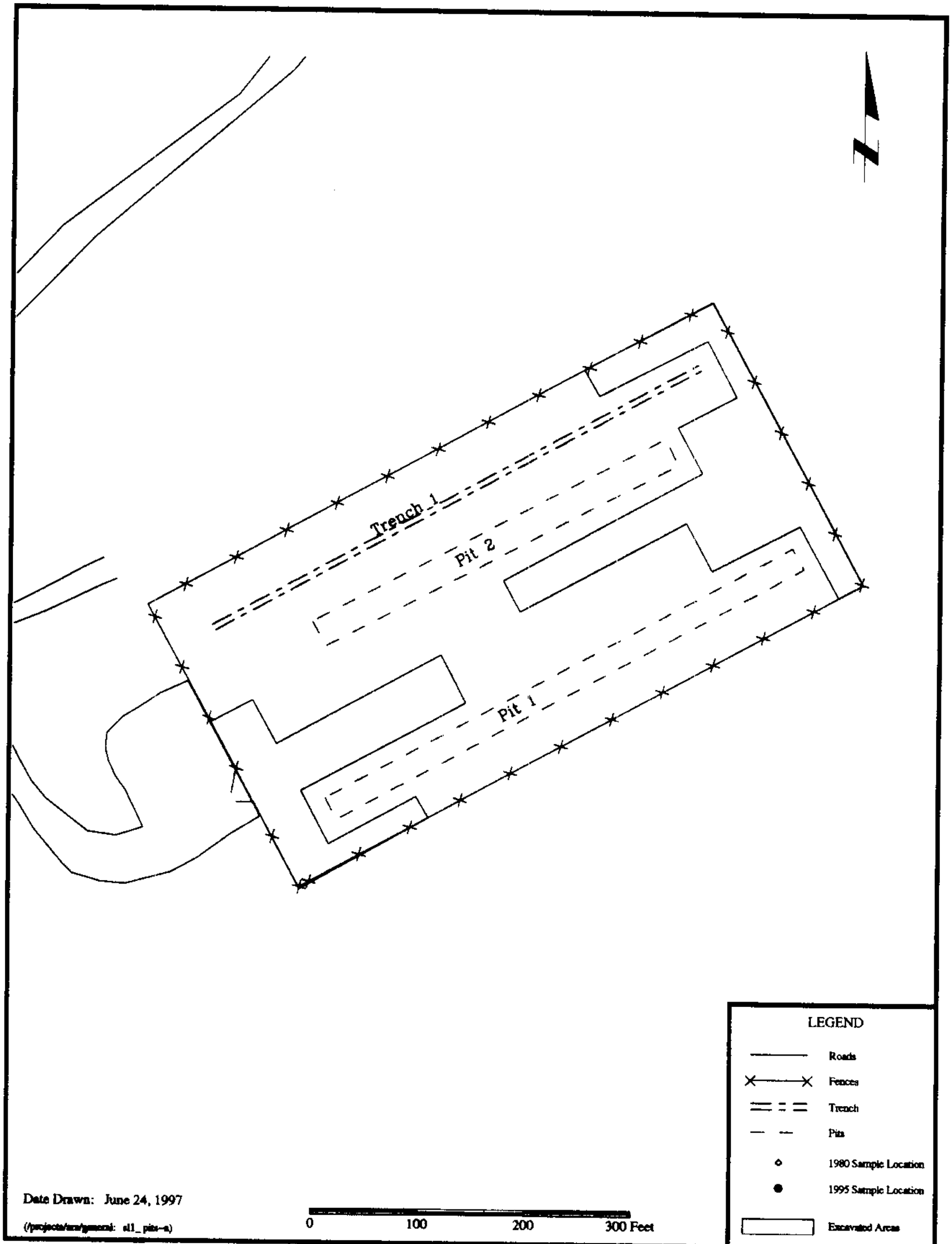

Figure 1-1. SL-1 burial ground pits and trench.

materials from nearby buildings, and soil and gravel contaminated during cleanup operations were disposed in the burial ground. The majority of buried materials consists of soils and gravel.

1.2.2 SL-1 Burial Activities

The SL-1 burial ground was constructed approximately 488 m (1,600 ft) northeast of the SL-1 site (Auxiliary Reactor Area [ARA] II in Figure 1-2). In October 1961, a trench 1.8 m (6 ft) wide, 3 to 4.9 m (10 to 16 ft) deep, and 151 m (495 ft) long was excavated. The variation in depth was attributed to the depth to bedrock, which ranged from 3 to 4.9 m (10 to 16 ft). A pit (Pit 1) 3.7 m (12 ft) wide, 3 m (10 ft) deep, and 142 m (466 ft) long was excavated parallel to the trench. It became apparent during the cleanup operation that the combined volume of Pit 1 and the trench was inadequate. In January 1962, a second pit (Pit 2) was constructed between and parallel to Pit 1 and the trench. Pit 2 was 6.1 m (20 ft) wide, 3 m (10 ft) deep, and 122 m (400 ft) long. Concrete monuments were placed at the ends of each pit and the trench.

Approximately 2,800 m^3 (99,000 ft^3) of radioactively contaminated debris were buried in the SL-1 burial ground. Debris was transported to the burial ground by dump truck or crane. Two crawler tractors dragged the concrete operating floor to the burial ground. As disposal progressed backfill was placed over the debris in the pits and trench until the radiation levels were less than 1 mrem/hr.

When demolition of the SL-1 building was complete, surface soil was removed from inside the fenced SL-1 area and from the road leading from the SL-1 area to the burial ground (AEC 1962). The contaminated dirt and gravel were spread over the entire length of the trench and Pit 2. Clean backfill was then placed over the pits and trench to a minimum depth of 0.7 m (2 ft). To facilitate runoff of precipitation, additional backfill was mounded over the trench and Pit 2, and another mound was placed over Pit 1 (Holdren 1994).

1.2.3 BORAX-I

The BORAX-I was a small experimental reactor used in the summer months of 1953 and 1954 for testing boiling-water reactor technology. In 1954, the design mission of BORAX-I was completed, and the decision was made to make one final test, which resulted in the intentional destruction of the reactor. The destruction of the reactor contaminated approximately 7,800 m^2 (84,000 ft^2) of the surrounding terrain. Immediately following the final test of the BORAX-I, much of the radioactive debris, including some fuel residue, was collected and buried onsite in the reactor shield tank. Recovered fuel fragments and fuel residue were sent to the ICPP and Oak Ridge National Laboratory in Tennessee. Reusable equipment associated with the reactor was successfully decontaminated and used in the construction of BORAX-II. However, the cleanup did not sufficiently reduce the radioactivity at the site; therefore, the 7,800 m^2 (84,000 ft^2) contaminated area was covered with approximately 15 cm (6 in.) of gravel to reduce radiation levels at the ground surface.

1.2.4 BORAX-I Burial Activities

Buried materials at the site consist of unrecovered uranium fuel residue, irradiated metal scrap, and contaminated soil and debris. Part of the waste was buried in the bottom half of the shield tank. The top half of the tank was collapsed into the bottom and the void space was filled with debris. The burial ground is contained within the foundation of the BORAX-I installation, the dimensions of which are 5.5 × 9.8 × 3.4 m (18 × 32 × 11 ft). A mounded gravel and dirt cover approximately 1.5 m (5 ft) high and 9 m (30 ft) in diameter is centered over the buried shield tank. The OU 6-01 includes the buried debris, as well as the 7,800 m^2 (84,000 ft^2) of contaminated surface soil.

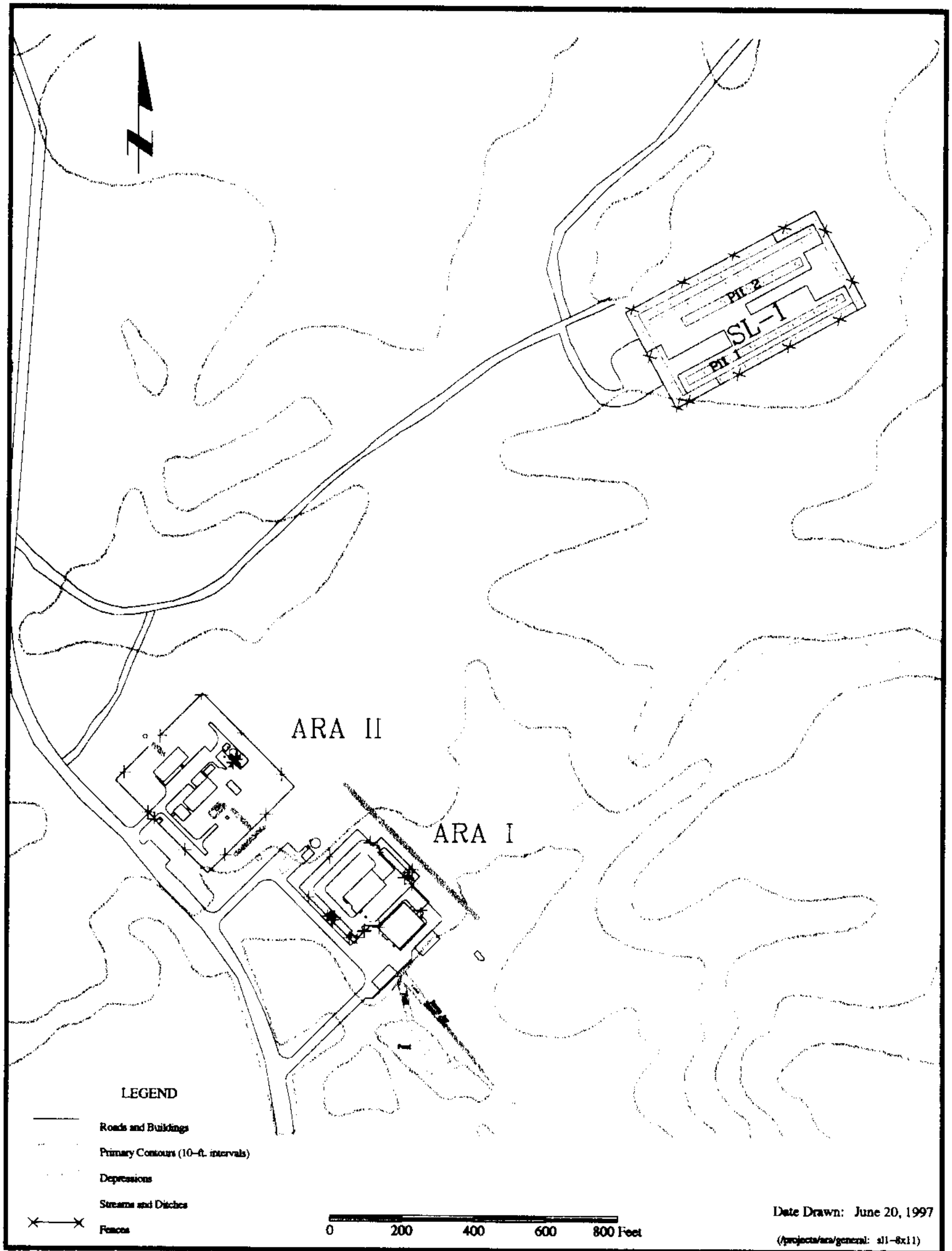

Figure 1-2. SL-1 burial grounds.

Field radiation surveys conducted in 1978 and 1980 detected radiation at about three times the background levels in the central portion of the gravel-covered 7,800 m^2 (84,000 ft^2) area south-southeast of the buried reactor. Radiation in adjacent areas was at background levels. Surface and subsurface soil sampling of the 7,800 m^2 (84,000 ft^2) gravel-covered area in 1978 and 1980 indicated that radioactive contamination existed and was highest at a depth of approximately 15 cm (6 in.); at the interface of the gravel cover and the original ground surface. Ongoing monitoring of the site through the use of radiation dosimeters showed that radiation levels were slightly above background levels. On November 18, 1994, the radiological field measured at 0.75 m (2.5 ft) above the surface of the BORAX-I burial ground (Figure 1-3) was 0.1 mrem/hr; local background radiation was also 0.1 mrem/hr.

Before remedial design/remedial action (RD/RA) activities, the ground surface at the site looked very much like the surrounding terrain. Abundant native vegetation had grown over the mound and surrounding area. A large stake about 1.5 m (5 ft) tall marked the reactor location. A 1.8-m (6-ft) high chain-link fence surrounded the burial ground, forming an enclosed area approximately 30 m (100 ft) on each side. The contaminated surface soil area which was outside of the chain-link fence was bounded by a two-wire exclusion fence. The fences, posted with radiological-control signs, and restricted access were to protect INEEL workers and the public from unacceptable exposures.

1.3 Organization of the Remedial Action Report

This report has two primary sections: (1) the body of the report, and (2) its appendices. The report body summarizes the remedial action activities in Section 2 and outlines the costs incurred by remedial action in Section 3. Remedial Action Work Plan modifications are identified in Section 4 and Section 5 discusses the waste streams generated during this project. Section 6 addresses the prefinal and final inspection checklist, Section 7 includes the summary and verification of the work performed, Section 8 certifies the finished product functions as designed, and Section 9 lists the references.

The appendices, attached for reference, include the following:

- Asbuilt drawings and layer thickness measurements
- Photographs
- Barrier material test reports
- Sample data
- Rip-rap borrow source maps
- Prefinal and final inspection checklist.
- Operation and Maintenance (O&M) Plan (Appendix G)
- INEEL Facility Land Use Master Plan update verification letter (Appendix H).

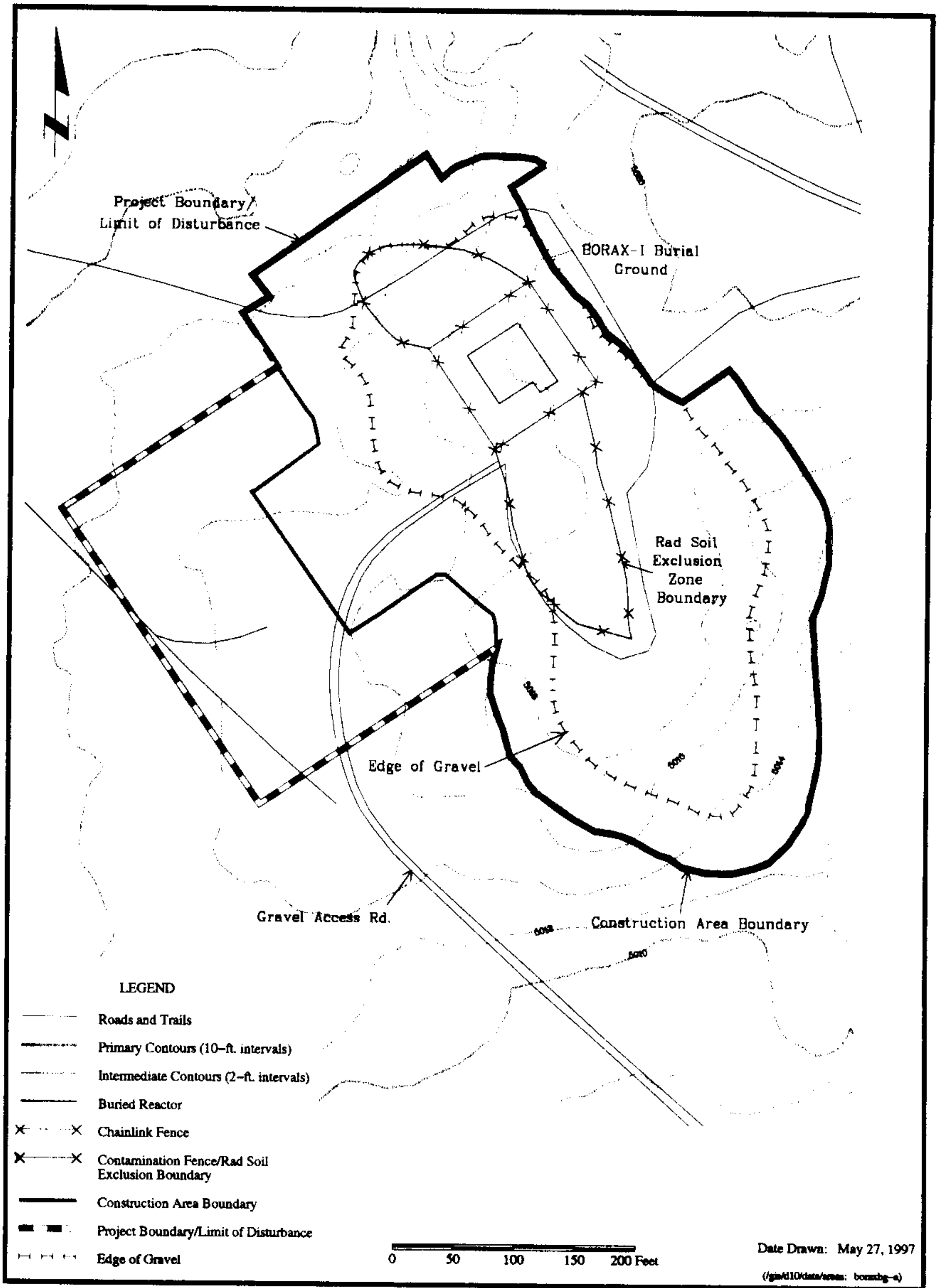

Figure 1-3. BORAX-I burial grounds.

2. DISCUSSION OF THE REMEDIATION ACTIVITIES

2.1 Remedial Action Working Documents

The RD/RA Work Plan lists the design criteria, describes the remedial design and how it was implemented, and served as the guidance document for the SL-1/BORAX-I engineered barriers project. The following documents were included as appendices to the RD/RA Work Plan:

- Health and Safety Plan (HSP), INEL-95/0636
- Operations and Maintenance Plan, Appendix G
- Civil design drawings
- Specifications
- Erosion calculations
- Quality level evaluation

The following documents were also required:

- Statement of Work
- Vendor Data Schedule (VDS)
- Special Conditions
- Field Sampling Plan (FSP)
- Storm Water Pollution Prevention Plan (SWPPP).

Some of the above listed documents were not required by or provided to the Subcontractor to perform the construction activities. The request for proposal letter located in the project files lists all documents provided to the Subcontractor.

2.2 Site Preparation and Mobilization

The efforts performed prior to initiation of remediation activities included providing required training to personnel, preparing the work area, and reviewing of regulatory requirements to ensure the work being performed would be performed to all codes as specified in the contract documents. The following sections discuss these activities.

2.2.1 Personnel Training Requirements and Support Facility Setup

Prior to the start of field work, Contractor and Subcontractor personnel assigned to the project were required to have a baseline medical examination and the training specified in the HSP, which included the following:

- INEEL site-specific orientation and security briefing
- 40-hour Hazardous Waste Operation training
- Work Site orientation
- HSP training
- Emergency Action at the worksite
- 24-hour Hazardous Waste Operation on-the-job training.

In addition, Contractor and Subcontractor personnel entering the exclusion zone were required to have whole body counts at the Whole Body Counting Facility, Central Facilities Area (CFA) 690 and Radiological Worker II training. Two Medic-First trained individuals were required to be onsite at all times during work activities.

Training certification and updates are maintained in the project files. The Subcontractor was required to update a training matrix and to submit this matrix to the construction engineer (CE) on a weekly basis.

After the Subcontractor completed all prerequisites for mobilization as detailed on a Readiness Assessment Checklist (also located in the project files) and personnel completed the training, support facility setup for BORAX-I began. The following actions were conducted:

- The Subcontractor setup office trailers at the CFA
- The project files, phones, fax machine, copy machine, and other office equipment were setup in the CFA office trailers
- The heavy equipment was inspected and brought onsite
- The Subcontractor improved an access road to the BORAX-I site; setup the laydown area, the site trailer, and portable generator; installed a fuel tank with secondary containment; and set up the construction rope boundaries
- Portable sanitation facilities and all required safety equipment (fire extinguishers, spill kits, eye wash stations, etc.) installed/inspected at the work site completed the support facility setup.

2.2.2 Regulatory Compliance

According to the CERCLA, Section 121, response actions conducted entirely onsite are exempt from obtaining federal, state, or local permits. However, this remedial action was required to comply with the substantive aspects of applicable or relevant and appropriate requirements (ARARs), and to be considered (TBC) requirements identified in the ROD as follows:

- *Idaho Air Pollution Act* Sections 16.01.650 and .651, "Rules for the control of Fugitive Dust and General Rules" (ARARs)

- DOE 5400.5, "Radioactive Protection of the Public and Environment" (TBC)

- DOE 5820.2A, "Radioactive Waste Management" (TBC).

To protect personnel from exposure to possible airborne contaminant emissions, dust control was provided so that visible dust was minimized during construction activities. This was accomplished by two water trucks prewatering excavation areas and spraying water on the soil during loading and hauling operations. Equipment routes in the exclusion zone were watered to minimize the generation of dust. During work with contaminated soil, work was stopped at indications of visible dust and when the wind speed approached 25 mph, averaged over a 15-minute period.

The DOE Order 5400.5 required radiological control technicians (RCTs) to be present at the jobsite during construction activities to ensure Radiological Control (RADCON) procedures for each task were followed. The required personal protective equipment (PPE) for the most part consisted of leather gloves and natural latex boot covers. Additional PPE was required for activities such as decontamination as outlined in the HSP and directed by RADCON. Equipment operators within the exclusion zone placed beta/gamma monitoring instruments within the equipment cabs in order to frisk themselves prior to entering the cabs. This was to ensure that the cabs would not be contaminated.

The DOE Order 5820.2A establishes policies, guidelines, and minimum requirements by which DOE manages it radioactive and mixed waste and contaminated facilities. The INEEL procedures and guidelines developed in accordance with DOE Order 5820.2A for generation, storage/transportation, and disposal of radioactive waste were followed. The DOE Order 5820.2A also addresses future control of sites. Fencing, signs, and institutional controls such as land use restrictions are intended to maintain control of these low-level radioactive waste disposal sites for 100 years following closure. The DOE Order 5820.2A also contains certain management of low-level waste performance objectives, one of which is to assure that the committed effective dose equivalents received by individuals who inadvertently may intrude into the facility after the loss of active institutional control (100 years) will not exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. This objective is met by consolidation of surface soils contaminated with radionuclide activity above the action levels specified in the ROD (see Section 1.1) and capping the burial grounds with a human intrusion barrier.

2.2.3 INEEL Work Permit Requirements

In order to comply with INEEL procedures, the following permits were required for the work to proceed:

- Outage request forms were required for excavation work at both SL-1 and BORAX-I

- An INEEL gravel/borrow request form was required for each type of material: pea gravel, rip-rap, cobble, and general backfill/gravel

- A safe work permit was required to be obtained weekly

- INEEL radiological work permits were prepared and issued by the RADCON organization

- A hot line hold order was needed by the INEEL Power Management group when the Subcontractor was loading rip-rap with a trackhoe under power lines.

2.3 Remedial Action

This section describes the construction activities performed to meet the RAOs as specified in the ROD and listed in Section 8.

The action levels of radionuclide-contaminated soils are delineated in Section 2.4.1. Radionuclide concentrations in soils above these levels could pose a total excess cancer risk greater than one in 10,000 for a subsistence farmer occupying the land 100 years in the future at SL-1 and BORAX-I. These are the contaminants of concern (COC) action levels specified in the ROD as developed by the baseline risk assessment contained in the *Remedial Investigation/ Feasibility Study Report for Operable Units 5-05 and 6-01*, INEL-95-0027, Revision 0, March 1995.

2.3.1 Development of Access Roads

Development of access roads began on July 22, 1996. Two access roads existed at the BORAX-I burial site. The main road is east of BORAX-I and provides access to BORAX-V; a smaller two track road is on the west side of BORAX-I. Due to the prevailing wind direction and the concern over fugitive dust, the western access road was widened and graveled. An area on the west side of BORAX-I was graded and graveled and served as the project laydown area.

The single track lane into SL-1 was grubbed and replaced with a graveled road suitable for heavy truck traffic which required a 18.3 m (60 ft) long by 38 cm (15 in.) diameter culvert to be installed at the junction with Fillmore Road. In addition to the support area around the site trailer, a truck turnaround was constructed at SL-1.

Gravel for the access roads, support areas, and turnarounds was obtained from the BORAX-V gravel pit.

2.3.2 Surface Grubbing

Surface grubbing prior to soils excavation and consolidation is necessary to eliminate potential pathways for insects through the consolidated soils layer.

The BORAX-I soil contamination areas were grubbed. The grubbed materials including shrubs, roots, signs, fencing, and other debris were placed on the burial ground in a layer not exceeding 15 cm (6 in.) at BORAX-I. The chain-link fence at BORAX-I was also removed and disposed with the grubbed material.

At SL-1 the single track leading into the site was grubbed prior to placement of gravel. This resulted in three 7.7 m^3 (10 yd^3) truckloads of grub material being hauled to the CFA bulky-waste landfill. All grub material going to the landfill was surveyed by RADCON prior to release. The other areas at SL-1 requiring grubbing included the excavation areas, fence lines, berm construction areas, and berm borrow source areas; all within the exclusion zone fence. This grubbed material was placed between Trench 1 and Pit 2 in a 15-cm (6-in.) layer.

2.3.3 Berm Construction

The ROD and RD/RA Work Plan required a berm to be built around the SL-1 site as part of the final grading and drainage plan. The Subcontractor was required to divert surface water around the periphery of all excavation areas and provide for dewatering work areas and controlling surface water prior to and throughout construction operations. Therefore, the berm was constructed prior to excavation activities as shown on drawing 6548C06 sheet C-06 (DOE 1996). Material for the berm was obtained from the berm borrow source area located north east of the SL-1 engineered barriers outside of the existing chain-link fence. Berms were not required for BORAX-I since the ground surface slopes away from the construction site.

2.3.4 Consolidation of Radionuclide-Contaminated Soils at BORAX-I

The BORAX-I radionuclide-contaminated soil areas that were determined to be above the action levels were initially excavated to a depth of 0.3 m (1 ft) using a Caterpillar (Cat) 320L trackhoe. The trackhoe then emptied the soil into the bucket of a Cat 950-F loader which spread the soil in the consolidation area in 15-cm (6-in.) lifts. During all excavation/handling of soils, a water truck was used for dust control. The consolidation area is within the approximately 37 × 37 m (120 × 120 ft) area of the new chain-link fence location as shown on drawing 65480CO2, sheet C-02 (DOE 1996). The consolidated soil lifts were compacted with a Cat 950-F loader and four passes of a Cat CS-563C smooth drum roller.

Subsequent to the initial excavation efforts, soil samples were taken again and analytical results showed three BORAX-I areas which still exceeded the 16.7 pCi/g Cs-137 and 10.8 pCi/g Sr-90 ROD action levels and no areas were above the 13.2 pCi/g U-235 ROD action level. The remaining "hot spots" were hand excavated resulting in approximately 10, 19-L (5-gal) buckets of contaminated soil. One location still contained contaminated soil after the hand excavation and this area was further excavated using the trackhoe. Approximately 1.5 m^3 (2 yd^3) of contaminated soil was removed from this spot and deposited/compacted on the soil consolidation area. A total of 560 m^3 (733 yd^3) of radionuclide-contaminated soil from five areas was consolidated and compacted over the BORAX-I burial site. All BORAX-I areas were then below the radionuclide concentration action levels as shown by verification sample results.

2.3.5 Consolidation of Radionuclide-Contaminated Soils at SL-1

The SL-1 excavation areas are shown on drawing 65480C05, sheet C-05 (DOE 1996). These areas were initially excavated using two front-end loaders, to a depth of 15 cm (6 in.) resulting in 676 m^3 (885 yd^3) of contaminated soil. This soil was transported to and spread on the soil consolidation area between Trench 1 and Pit 2 using the two front end loaders. Each 15-cm (6-in.) lift was compacted using a Cat CS-563 smooth drum roller. The soil consolidation area is approximately 162 × 12 m (530 × 40 ft). Soil sampling and analysis took place following each excavation effort. Sampling and analysis methods included laboratory analysis to identify areas above the 16.7 pCi/g Cs-137 action level.

While waiting for the initial soil sampling laboratory results it was determined that a large number of "hot spots" still needed excavation based on RADCON survey using a sodium iodide scintillation detection instrument. These areas were identified using surveyor marking paint as directed by the RCT. Laboratory analysis of initial soil samples also indicated remaining "hot spots." The initial laboratory analysis and RCT field surveys resulted in the excavation of 715 m^3 (936 yd^3) of contaminated soil.

The excavation areas were resampled and required an additional 452 m^3 (591 yd^3) of further excavating. The areas continued to be excavated using sample results and the sodium iodide scintillation detection instruments until all areas were below the ROD action levels. A total of 1,840 m^3 (2,408 yd^3) of contaminated soil was excavated and became part of the SL-1 consolidated soil layer.

2.3.6 Auxiliary Reactor Area/SL-1 Investigation-Derived Waste

Four 1.2 × 2.3 × 0.61 m (4 × 8 × 2 ft) wooden boxes and four 19-L (5-gal) buckets of investigation-derived waste (IDW) from particle picking efforts in the SL-1 area were emptied into the SL-1 soil consolidation layer and compacted using the smooth drum roller. This IDW had been previously characterized and approved for deposition within the consolidated soil layer (Interdepartmental communication, *Release of ARA-I, ARA-II, and SL-I Burial Ground Area Soils to SL-1 Burial Ground Area Soils to SL-1 Burial Ground Area of Contamination* - JMC-22-96, Joan M. Connolly, August 7, 1996). The contaminant range in the IDW soils was 5.7 to 115 pCi/g Cs-137, 0.09 to 0.16 pCi/g Co-60, 0.67 pCi/g Eu-154, 1.12 to 1.53 pCi/g Th-232, 1.27 to 1.83 pCi/g Th-128, 1.83 to 2.78 pCi/g Th-230/U-234, and 0.84 to 9.7 pCi/g U-238.

2.3.7 Biotic Barrier

A biotic barrier to inhibit biotic intrusion at SL-1 was placed over the pits and trench. This biotic barrier is to prevent small mammals and insects from carrying radioactive particles to the surface. The biotic barrier consisted of three parts, 10 cm (4 in.) of pea gravel covered by 30 cm (12 in.) of cobble and topped by another 15 cm (6 in.) of pea gravel.

2.3.7.1 Lower Pea Gravel Layer. A 10-cm (4-in.) thick pea gravel (0.6 to 1.3 cm [$^1/_4$ to $^1/_2$ in.] diameter) layer was placed over the pits and trench as shown on drawing 65480C09, sheet C-09 (DOE 1996). The test reports for the pea gravel are included in Appendix C. The pea gravel was obtained from the Lincoln pit. Figure 2-1 shows a map of the INEEL and the location of the Lincoln Boulevard Pit. The gravel was dumped on the west end of the exclusion zone by 11-m (12-yd) trucks at the zone boundary. Front-end loaders within the exclusion zone picked up and hauled the pea gravel to the placement location. Inplace-layer thickness measurements were performed by the field crew and verified by the CE. Pin flags were placed where additional materials needed to be placed. Three areas were identified which required more pea gravel. Approximately 754 m^3 (980 yd^3) of pea gravel was placed in the first layer.

2.3.7.2 Cobble Rock Layer. Since there is no INEEL-Site source of cobble rock, the cobble was hauled from Idaho Falls. The cobble rock was delivered to the SL-1 jobsite in 15-m^3 (20-yd^3) end-dump trucks pulling pup trailers. In order to shorten the truck route and mitigate the effects of heavy truck traffic, arrangements were made with Site security to enter the INEEL-Site through the US 20/Fillmore Road gate. The cobble (5 to 15 cm [2 to 6 in.] diameter) was dumped at the turnaround area by the pup trailers and end-dump trucks then moved to the exclusion zone boundary using a Cat IT 24F front-end loader. A Cat 950F front-end loader within the exclusion zone picked up the cobble and spread it over the first pea gravel layer in a 30-cm (12-in.) thick layer. The field crew performed thickness measurements as the work progressed. Several areas had to have more cobble placed prior to the final thickness measurements as shown in Appendix A. Approximately 1,720 m^3 (2,248 yd^3) of cobble was placed at SL-1.

2.3.7.3 Upper Pea Gravel Layer. The upper pea gravel (0.6 to 1.3 cm [$^1/_4$ to $^1/_2$ in.] diameter) layer consisted of 15-cm (6-in.) thickness placed over the 30-cm (12-in.) cobble layer. Again the field crew performed layer thickness measurements. More gravel had to be added at four locations to obtain the proper thickness. Approximately 2,002 m^3 (2,600 yd^3) of pea gravel was placed in the second layer.

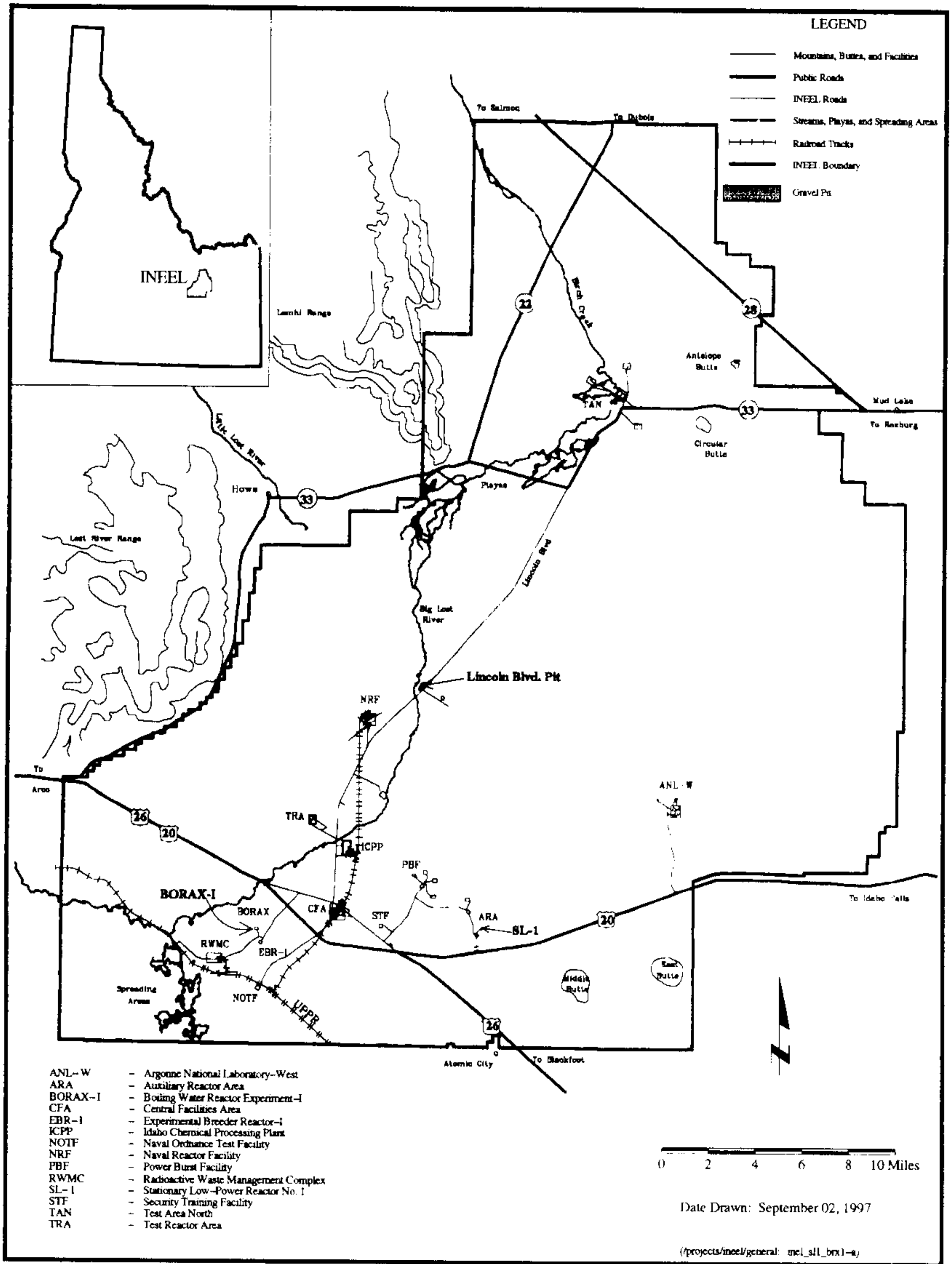

Figure 2-1. Map of the INEEL.

2.3.8 Human Intrusion Barrier

A barrier was placed over the consolidated soil at both the BORAX-I and the SL-1 burial sites in order to prevent humans from inadvertently intruding on these areas. It consists of large, angular basalt boulders (rip-rap). At the BORAX-I burial site, the inadvertent human-intrusion barrier was placed over the consolidated contaminated soils. At the SL-1 burial ground, the inadvertent human-intrusion barrier was placed over the biotic barrier and consolidated contaminated soils.

2.3.8.1 Rip-Rap Layer. Originally all the rip-rap was to be obtained from the ICPP storm ponds blast pile located in a line south of the ICPP. As work progressed more rip-rap was needed than was available in the ICPP location and it became necessary to locate and process the necessary paperwork to use rip-rap from additional sources. The additional sources are located near the Security Training Facility (STF), Dike road, Organic Moderated Reactor Experiment building and Antelope substation. The Cultural Resource Management group performed an archaeological evaluation/survey for each additional rip-rap location and no archaeological sites were found. After approval, maps for these areas showing the new construction roads and remediation/reseeding requirements were added to the SWPPP and are included in Appendix E as rip-rap borrow source maps. The construction roads leading into these areas were recontoured/graded and reseeded in April, 1997.

Loading and hauling the rip-rap required several trackhoes for loading, 4 to 10 trucks for hauling, and one front-end loader for performing miscellaneous tasks. A clean road was installed from the exclusion zone boundary along the engineered barrier. This allowed the trucks hauling rip-rap to back down these clean roads and place or stockpile rip-rap within reach of the trackhoe performing the placement. The clean roads consisted of approximately 15 cm (6 in.) of clean gravel/dirt mix obtained from the BORAX-V pit spread over the contaminated soil in the exclusion zone. After spreading the gravel/dirt, radiological surveys were performed to ensure no contamination was found on the road surface after which it was roped off and posted as an Underground Radioactive Materials area. This allowed the drivers to drop off the rip-rap without entering the soil contamination area/exclusion zone. A clean road was constructed along the north side of Pit 1, between Trench 1 and Pit 2 at SL-1 and along the south side of the BORAX-I cap. The trackhoe could reach the stockpiled rip-rap on these clean roads and place it one or two rocks at a time over the engineered barrier.

The field crew performed thickness measurements and inspected for voids as the work progressed. Adding rip-rap and filling voids was done while the trackhoe was within reach of the repair location. Approximately 5,811 m^3 (7,600 yd^3) of rip-rap was placed on the engineered barrier at SL-1, and approximately 952 m^3 (1,245 yd^3) at BORAX-I.

2.3.9 Fencing

Fences and gates were erected around both the SL-1 and BORAX-I burial grounds with orientation and location as shown on drawings 65480C03, 65480C06, and 65480C11 (DOE 1996). The fencing is 1.8-m (6-ft) high chain-link with top rail. The posts were set at a spacing of 3 m (10 ft) on center and encased in concrete. The gate at SL-1 is double swing, 4.8 m (16 ft) long, and the gate at BORAX-I is single swing, 3.6 m (12 ft) long. Eight "Keep Out" signs were placed on the fencing at each site. CERCLA signs indicating the OU and persons to contact were also installed at each site.

2.3.10 Monuments/Markers

Four granite monuments were installed at the SL-1 site and two granite monuments were placed at the BORAX-I site. These monuments are designed to remain in existence for at least 400 years to discourage any individual from inadvertently intruding into or contacting the buried waste. The monuments are 1.2 m (4 ft) wide by 25 cm (10 in.) thick by 1.2 m (4 ft) high solid granite placed on a $1.2 \times 1.8 \times 0.3$ m ($4 \times 6 \times 1$ ft) concrete footing. The monuments were anchored to the footings by epoxy grouting to rebar protruding from the footings. Symbols and markings etched into the face of the monuments warn potential intruders. The symbols and etching design is based on the Sandia Report, *Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant* (Trauth, Hora, and Guzowski 1993). Brass surveyor caps stamped with the United States Geological Survey (USGS) coordinates were installed into the top of each marker. In addition to the monuments, two concrete-filled steel pipe markers, topped with USGS-coordinate-stamped brass caps, were installed at BORAX-I.

2.4 Environmental Sampling and Analysis

The environmental sampling conducted for the SL-1/BORAX-I engineered barrier construction and the analytical results from this sampling are discussed in the following sections.

2.4.1 Sampling Objectives

The sampling objectives identified in the OUs 5-05 and 6-01 ROD and detailed in the FSP for the SL-1/BORAX-I Engineered Barriers Remedial Action were to confirm that soil concentrations were equal to or less than the COC action levels, which are 16.7 pCi/g of Cs-137 at the SL-1 site and 16.7 pCi/g of Cs-137, 13.2 pCi/g of U-235, and 10.8 pCi/g of Sr-90 at the BORAX-I site.

2.4.2 Quality Assurance and Quality Control

The quality assurance (QA) objective for the sampling conducted for the SL-1/BORAX-I engineered barriers was to produce data acceptable for use by the EPA, IDHW, and the DOE-ID. This is achieved by controlling sample collection, sample transfer, sample analysis and data reporting. Data was validated to Level A per Lockheed Martin Idaho Technologies Company (LMITCO) technical procedure (TPR), "Levels of Analytical Methods Data Validation" (TPR-79), in accordance with Radiological Data Validation procedure (SMO-SOP-12.1.2). Qualified laboratory sample results were tabulated in data limitation and validation reports and the data reside in the Environmental Restoration Information System.

The quality assurance/quality control (QA/QC) samples are collected and analyzed to confirm the achievement of project objectives and data quality objectives (DQOs). Precision, accuracy, completeness, and comparability are discussed in the following subsections. How these DQOs were evaluated, and the extent to which they were achieved are also discussed.

Spatial variations are present in concentrations of contaminants at a site, creating sampling variability. Additional variability, referred to as measurement error, occurs during sample collection, handling, processing, analysis, quality evaluation, and reporting. Reported concentrations of contaminants represent the true concentrations in the media samples plus the measurement error, which can be minimized but not eliminated. Although it may not be significant in many cases, it is important to assess the contribution of measurement error to the total error in individual investigations. This is done by using the results of QC samples to estimated accuracy and precision, quantitative estimators of measurement error and bias.

2.4.2.1 Precision. Precision is a measure of the reproducibility of measurement under a given set of conditions. In the field, precision is affected by sample collection procedures and the natural heterogeneity of the matrix. Overall precision (field and laboratory) can be evaluated by the use of duplicate samples collected in the field. Greater precision is typically required for analytes with very low action levels that are close to background concentrations. During the sampling, duplicate soil samples were collected from one location at the BORAX-I site and five duplicate soil samples from various locations at the SL-1 site. The analysis of these samples provides an estimate of measurement error coming from subsampling, analysis, and data recording, but they cannot be used to estimate the overall measurement error coming from short range spatial variation, sample collection, and handling plus subsampling, analysis, and data recording.

The results of the regular and duplicate analyses and the relative percent differences (RPDs) for the pairs are shown in Table 2-1. The RPDs were calculated for each contaminant with positive detection in both the regular and the duplicate samples. The calculated RPDs ranged from 4.8% to 200% for Cs-137 and is 40% for the one Sr-90 duplicate pair. The large variability between the regular and duplicate samples is attributable to the collection technique. Regular samples were bias collected by first performing field screening to determine the location of areas of higher contamination, then collecting the sample once the "hot spot" was located. The duplicate samples were collected in the same location following the removal of the "hot spot" during collection of the regular sample.

Laboratory precision is part of the validation criteria against which laboratory data are evaluated. More information on the validation of the radioanalytical results can be found in the data limitation and validation (L&V) reports .

2.4.2.2 *Accuracy.* Accuracy is a measure of bias in a measurement system. Accuracy is affected by sample preservation and handling, field contamination, and the sample matrix in the field. The effects of the first three can be assessed by evaluation of the field and equipment blanks. Two rinsates were collected from sampling equipment during the BORAX-I removal action, and six rinsates during the SL-1 removal action. For the BORAX-I rinsates, one was collected prior to sample collection and the other following sample collection. Both BORAX-I rinsates were analyzed for gamma emitting isotopes and Sr-90. The post-sampling rinsate showed the presence of Sr-90 at a level of 1.3 ± 0.6 pCi/L. The presence of Sr-90 in the post-sampling rinsate sample indicates the possibility that the Sr-90 sample results may have a high bias attributable to contaminated sampling equipment. Neither of the two gamma rinsates showed the presence of any gamma emitters. For the SL-1 rinsates, three were collected prior to sample collection and three following sample collection. All six SL-1 rinsates were analyzed for gamma emitting isotopes and none were detected.

Laboratory accuracy is part of the validation criteria against which laboratory data are evaluated. More information on the validation of the radioanalytical results can be found in the data L&V reports.

2.4.2.3 *Completeness.* Completeness is a measure of the quantity of usable data collected during an investigation. The Quality Assurance Project Plan (QAPjP) requires an overall completeness goal of 90% for remedial actions and 100% for all critical samples identified in the remedial action objectives. For the SL-1/BORAX-I removal action, no critical samples were identified in the FSP. All samples were collected as required to confirm that the remedial action goals were met. None of these samples were rejected during the method data validation process; therefore, the calculated completeness is 100% and the completeness criteria has been achieved.

2.4.2.4 *Comparability.* Comparability refers to the confidence with which one data set can be compared to another. This is a qualitative characteristic that must be ensured in all aspects of the work, from preparation for sampling through reporting. Data comparability for this project was achieved through the use of standard operating procedures for all aspects of field sampling and the use of standard analytical methods obtained through the INEEL Sample Management Office. The laboratory followed

Table 2-1. Regular and duplicate analysis and relative percent difference for the analytes.

Analyte	Sample ID	Regular Sample Result (pCi/g)	Duplicate Sample Result (pCi/g)	Relative Percent Difference
Cs-137	BRX002	310 ± 20	0.71 ± 0.09	200
Sr-90	BRX002	0.8 ± 0.2	1.2 ± 0.3	40
Cs-137	SL1001	123 ± 9	6.3 ± 0.5	180
Cs-137	SL1010	420 ± 30	400 ± 30	4.8
Cs-137	SL1011	610 ± 50	5.6 ± 0.4	196
Cs-137	SL1024	213 ± 15	10.3 ± 0.8	181
Cs-137	SL1031	10.9 ± 0.9	18.6 ± 1.4	52

standard QA/QC procedures as outlined in the radioanalytical statement of work, Idaho National Engineering Laboratory Sample Management Office Statement of Work for Radionuclide Analysis, and met the required detection limits specified therein.

2.4.3 Remedial Action Sampling

Initial sampling was conducted in accordance with field sampling plans transmitted by interdepartmental communications (LMITCO Interdepartmental Communications, Jorgensen, October and November 1995). Results of this sampling conducted in October and November 1995, established the areas requiring initial excavation and consolidation in the consolidated soils layer for both SL-1 and BORAX-I.

Subsequent soil sampling was conducted in accordance with the project FSP, DOE/ID-10540 to verify that the excavation had been successful in meeting the RAOs. After an area had been excavated, soil sampling for radionuclide analysis was performed. The excavated areas were also surveyed using sodium iodide scintillation detectors. Locations with high readings underwent particle picking to remove hot particles. After particle picking, one grab sample per grid was pulled from the location of highest field within each grid. Where no high field was present in a grid, the grab sample was pulled from the grid center. The samples were analyzed at the Radiation Measurements Laboratory using gamma spectroscopy.

Where results determined that radionuclide levels exceeded the action levels within any grid, a second excavation was performed on that grid by the Subcontractor. Following the second excavation the grid was resurveyed and samples taken using the same method.

Sample material that was collected for analysis was returned to the site after analysis for inclusion in the consolidated soils layer.

One deviation from the FSP occurred which was issuance of two samples with the same sample number. Documentation for correction of this error is located in the project files. Document Action Request No. ER-DAR-347 was issued to make the project HSP consistent with the project FSP.

Results of the sample analysis are included in Appendix D. The final sampling results verified that the COC soil concentrations were less than the action levels specified in the ROD.

2.5 Occupational Health and Safety

2.5.1 Industrial Hygiene Summary

The following sections discuss the industrial hygiene (IH) sampling conducted on the SL-1/BORAX-I project. Industrial hygiene monitoring was performed to evaluate occupational exposure to noise and heat stress.

2.5.1.1 Noise Surveillance. High noises for this project were associated with heavy equipment operations. Excessive exposure to high noise levels can cause both temporary and permanent hearing loss. Levels approaching 85 decibel A-weighted (dBA) warrant the implementation of a hearing conservation program in compliance with 29 Code of Federal Regulations 1910.95. The LMITCO IH, in conjunction with Subcontractor safety personnel, conducted routine tests on employees to ensure adequate hearing protection was being worn. Prior to the start of work, employees were required to have a current hearing exam. In addition to the exam, employees were required to be trained on the hazards of noise and the use and limitations of hearing protection. Noise dosimeters were provided to the loader operators and truck drivers to determine the need for ear protection. It was determined through monitoring that water truck drivers were subjected to the highest noise levels; however, these levels were less than 85 dBA.

2.5.1.2 Surveillance of Heat Stress. The majority of the SL-1/BORAX-I work took place in the hot summer months. The HSP identified the need to ensure employees were not getting heat stressed. This was accomplished by the IH and Subcontractor safety personnel performing periodic surveillance. The Subcontractor personnel were trained how to spot the symptoms of heat stress and what to do with a potential victim. The Subcontractor provided cool drinking water in the support zone for the personnel working in the field to help keep the personnel hydrated.

2.6 Decontamination

Prior to removing materials and equipment from the radiological exclusion zone, the material and equipment was subject to decontamination. Contamination was identified by RADCON frisking methods and by laboratory analysis of smear (swipes) samples obtained from equipment. Motorized equipment had the engine oil sampled and analyzed by the Radiation Measurements Laboratory prior to entry into the soil-contamination zones and again prior to release. Any equipment and materials that were contaminated (100 cpm above background using a Ludlum 2A portable frisking instrument) required decontamination prior to being removed from the controlled area.

As discussed in the RD/RA Work Plan, a temporary decontamination pad was required to be established at the control point for each burial site. However after consultation with RADCON management, it was decided that the decontamination pad may not be required if dry decontamination methods using shovels and brooms were used for the general debris and wire brushes/putty knives were used to remove "hot spots."

After the initial decontamination effort, the RCT surveyed the equipment/material for hot particles, if none were found the equipment/material was released. If contamination was detected and could not be removed using dry methods then wet methods were used. High pressure water spray was provided by a water truck parked outside the exclusion zone fence. The equipment was decontaminated within the soil contamination area and the water was dispositioned within the area. This method minimized the amount of radioactive waste generated in accordance with guidelines provided by the *Waste Minimization and Pollution Prevention/Awareness Plan* (DOE-ID 1992a).

2.7 Site Restoration

Site restoration included recontouring and reseeding the laydown/support areas, rip-rap source areas, and other locations impacted by construction activities. Excavation and berm borrow-source areas within SL-1 and BORAX-I exclusion zones also required recontouring, preparation of a seed bed, and reseeding. After preparation of a seed bed using a disc to till the top 7.6 cm (3 in.) of surface, the fertilizer was applied at a rate of 30 pounds per acre. After final grade was completed, the seed was drilled to a maximum depth of 1.3 cm (0.5 in.). The seed mixture was placed at a total of 12 pounds per acre. Straw mulch was applied at a rate of 2 tons per acre. Using crimping equipment, the straw was placed in the soil at a depth of at least 5 cm (2 in.).

2.8 Demobilization

The Subcontractor initially demobilized on December 16, 1996. Work that remained to be completed after demobilization in December 1996 was the reseeding of disturbed areas within the exclusion zones and support areas at both sites and recontouring/reseeding of the construction roads in and around the rip-rap source locations. The berm at SL-1 also needed building up on the west side and some minor punchlist items remained. The Subcontractor remobilized for this remaining work on April 14, 1997. After the final work was completed, the reseeding equipment was released by RADCON and removed from the INEEL site on April 23, 1997.

3. COSTS

Total project cost for the SL-1/BORAX-I sites RD/RA are listed in Table 3-1 below. These costs include the INEEL management and operations (M&O) Contractor's project management and government furnished equipment costs and lower-tiered Subcontractor labor and equipment costs.

Table 3-1. Remedial Design/Remedial Action costs.

Remedial Design	Cost
Remedial design	212,869
Remedial action work plan	63,022
Bid package	25,214
Remedial Action Field Work	**Costs**
Project/construction management/RA field work	208,664
ES&H supplies and support	104,763
Subcontract	827,970
Prefinal inspection/remedial action report	37,023
Project management/administrative support	150,837
Remedial Design/Remedial Action Total Cost	1,630,362

4. MODIFICATIONS TO THE REMEDIAL ACTION

Problems encountered during the remedial action were documented and resolved using the construction interface document (CID) procedure resulting in several modifications to the remedial action subcontract. Other CIDs were issued for clarification or resolution of discrepancies between the documents. The following discussion addresses the major problems encountered.

A radiological "hot spot" was discovered in the SL-1 support zone and a truck turnaround was needed, CID-003 was issued to add the turnaround and cover the "hot spot."

The moisture/density gauge used for density testing the fill material of the berms contained an internal radioactive source which precluded frisking the instrument out of the radiological controlled area. CID-014 was issued to delete the testing requirement; however, the requirement for two passes with a compactor remained.

Identification of additional soils requiring excavation and consolidation as a result of radiological survey and sampling caused issuance of CIDs 018, 026, 027, and 032.

The cobble gradiation requirements initially specified in construction specification 02200 exceeded the design size required and was not available in the local area (Idaho Falls). CID-015 changed the requirements to allow use of locally available cobble which still met the design requirements of 2 to 6 in. diameter size.

Construction specification 02200 required compaction of the biotic barrier layers including the cobble layer. A field test showed that compacting the cobble layer pushed the cobble into the underlying pea gravel. CID-015 deleted compaction of the cobble to protect the integrity of the underlying pea gravel layer.

Placement of the rip-rap by the trackhoes required the rip-rap to be unloaded within trackhoe reach. This required clean roads to be built so trucks could back down these roads and place/stockpile rip-rap within reach of the trackhoes. These clean roads were approved via CIDs 017, 025, and 034.

The CIDs with a description are given below.

5-05/6-01 SL-1/BX-001: Detail 4, drawing C-09 showed the consolidated soils layer overlapping the biotic barrier. This CID added detail 4A which showed the consolidated surface layer toe under the biotic barrier allowing the consolidated soils layer to be placed prior to the biotic barrier.

5-05/6-01 SL-1/BX-002: Construction specification 02930, *Reclamation Seeding and Mulching*, Paragraph 1.3.2 required the Subcontractor to submit the seed vendors certifications 8 working days after notice to proceed. This CID changed the time for submittal to 8 working days prior to use to agree with the vendor data schedule.

5-05/6-01 SL-1/BX-003: Added a turnaround at the SL-1 site support zone for truck traffic. This turnaround also covered an identified radiological "hot spot."

5-05/6-01 SL-1/BX-004: The vendor data schedule incorrectly stated that many of the "description of repair and/or replacement method" submittals were due "8 days after notice to proceed." This CID changed the submittal time to "before use" to agree with the various construction specifications.

5-05/6-01 SL-1/BX-005: Approved use of "dike road" rip-rap source for BORAX-I site.

5-05/6-01 SL-1/BX-006: Corrected discrepancy between special conditions and project HSP concerning clip on side shields for safety glasses and steel shank in work boots.

5-05/6-01 SL-1/BX-007: The coordinates for the existing survey monuments shown on the construction drawings were wrong. This CID transmitted the correct coordinates as provided by the LMITCO surveyors.

5-05/6-01 SL-1/BX-008: CID was voided.

5-05/6-01 SL-1/BX-009: Updated HSP telephone/radio contact list to reflect current information.

5-05/6-01 SL-1/BX-0010: CID was voided.

5-05/6-01 SL-1/BX-0011: The length of the culvert at the Fillmore Road/SL-1 access road junction as shown on the drawings was 12.2 m (40 ft). For trucks originating from the south, a 18.3 m (60 ft) culvert length was needed. The second culvert shown on the drawings was not needed. This CID approved these changes.

5-05/6-01 SL-1/BX-0012: Added a second mobilization at BORAX-I site to mitigate effects of waiting for sample results.

5-05/6-01 SL-1/BX-0013: Added disposition of four 1.2 × 2.3 × 0.6 m (4 × 8 × 2 ft) boxes and four 19-L (5-gal) buckets of sample radioactive waste to Subcontractor scope of work. This waste was added to the consolidated soils layer at SL-1.

5-05/6-01 SL-1/BX-0014: Deleted requirement of density test on fill material for berms since the moisture/density gauge contained an internal source which precluded frisking the instrument out of the exclusion zone.

5-05/6-01 SL-1/BX-0015: Changed gradation requirements for cobble rock to match design requirements and allow use of cobble available within 105 km (65 mi) of the site.

5-05/6-01 SL-1/BX-0016: Modified the turnaround at SL-1 to allow drive through of end-dump trucks.

5-05/6-01 SL-1/BX-0017: Approved use of clean haul roads for use in deposition of layer materials near placement location within the exclusion zone

5-05/6-01 SL-1/BX-0018: Added excavation and consolidation of an additional 1,167 m^3 (1,527.5 yd^3) of contaminated soils at SL-1.

5-05/6-01 SL-1/BX-0019: Corrected the vendor data schedule to reference the proper construction specification 02222 paragraph numbers 1.3.2 and 1.3.3.

5-05/6-01 SL-1/BX-0020: Deleted compaction of cobble layer and 15 cm (6 in.) pea gravel layer to protect integrity of layers.

5-05/6-01 SL-1/BX-0021: Approved the use of the US 20/Fillmore Road security gate to cut down haul distance for cobble material by the Subcontractor.

5-05/6-01 SL-1/BX-0022: Added hauling and placing of 871 m^3 (1,140 yd^3) gravel/dirt mix from BORAX V pit to SL-1 for backfill in excavation areas to Subcontractor's scope of work.

5-05/6-01 SL-1/BX-0023: Added the decontamination of three pieces of equipment to Subcontractors scope of work which allowed the subcontractor to use them on the landfill project pending the results of soil sample analysis.

5-05/6-01 SL-1/BX-0024: Standby time incurred on 8/19, 8/20, 8/27, 8/28, and 8/29/96 for partial crew and job setup (site trailer, generator, etc.) while awaiting soil sample results. Other large equipment was utilized on the landfills job to mitigate delay costs.

5-05/6-01 SL-1/BX-0025: Approved use of a clean haul road between Trench 1 and Pit 2 at SL-1 for placement of rip-rap within reach of the trackhoe.

5-05/6-01 SL-1/BX-0026: Directed Subcontractor to perform extra excavation (two, 3.1 × 3.1-m [10 × 10-ft] areas, 15 cm [6 in.] deep) at SL-1 due to additional contaminated soil.

5-05/6-01 SL-1/BX-0027: Directed Subcontractor to perform hand excavation of "hot spots" at BORAX-I site due to additional contaminated soil..

5-05/6-01 SL-1/BX-0028: Deleted requirement to dig a key for first row of rip-rap at SL-1 since the rip-rap being placed in the first row is of a size which does not need to be keyed.

5-05/6-01 SL-1/BX-0029: Revised construction specification 02200 to reflect CID 5-05/6-01 SL-1/BX-0020 disposition.

5-05/6-01 SL-1/BX-0030: Clarified training requirements for truck drivers who do not enter radionuclide-controlled areas and trackhoe operators who do not enter CERCLA zones.

5-05/6-01 SL-1/BX-0031: Added rip-rap located east of the STF near the Organic-Moderated Reactor Experiment as an approved source of rip-rap. The SWPPP and specifications were revised.

5-05/6-01 SL-1/BX-0032: Directed Subcontractor to excavate additional contaminated soil at BORAX-I as a result of a RADCON survey.

5-05/6-01 SL-1/BX-0033: Compensated the Subcontractor for an evacuation of the SL-1 jobsite and subsequent remobilization to BORAX-I due to bulging drums at the Waste Experimental Reduction Facility.

5-05/6-01 SL-1/BX-0034: Approval to construct a clean haul road at the BORAX-I site to deposit rip-rap within reach of the trackhoe.

5-05/6-01 SL-1/BX-0035: Approved placement of brass caps in the top of monuments with USGS coordinates and elevations inscribed on them rather than having the coordinates inscribed on the face of the monuments.

5-05/6-01 SL-1/BX-0036: Compensate the Subcontractor for Cat 322L and Cat 315L trackhoe excavator standby time.

5-05/6-01 SL-1/BX-0037: Subcontractor standby time for dike road rip-rap source location change.

5-05/6-01 SL-1/BX-0038: Contractor supplying force account ironworkers to Subcontractor for fence installation to avoid labor problems. The Subcontractor reimbursed the Contractor for costs.

5-05/6-01 SL-1/BX-0039: Approval of material properties and durability of brass caps.

5-05/6-01 SL-1/BX-0040: Standby time of crew working at BORAX-I for propane leak evacuation at RWMC, lost time due to guards scaring ducks off ICPP pond, and investigation of depleted smoke bombs found while loading rip-rap south of ICPP.

5-05/6-01 SL-1/BX-0041: Reimburse Subcontractor for 3 hours of down time due to RCT caused delays.

5. QUANTITIES AND TYPES OF WASTES GENERATED

5.1 Noncontaminated Personal Protective Equipment

The PPE requirements for the SL-1/BORAX-I barriers were identified in the HSP as level D, consisting of safety boots, street clothes, leather gloves, hard hats, and safety glasses. When entering the exclusion zone latex boot covers were required. These boot covers were frisked at the step off pad and reused if in good condition; therefore, the noncontaminated PPE waste consisted of damaged leather gloves and boot covers. Two bags (0.06 m^3 [2 ft^3]) of noncontaminated PPE waste was generated and disposed at the CFA landfill.

5.2 Contaminated Personal Protective Equipment

Anti-contamination PPE were surveyed and sorted into clean (to be reused if in good condition) or contaminated. During construction of the SL-1/BORAX-I engineered barriers, two pair of leather gloves and five sets of latex boot covers were contaminated. This waste was accepted and disposed by the LMITCO decontamination and decommissioning group along with other contaminated SL-1 waste at Waste Reduction Operations Complex (WROC) as low-level waste to be incinerated.

5.3 Noncontaminated Project Waste

Noncontaminated project waste includes office waste paper, bent metal T posts, fencing material, and three truck loads of grubbed material that were transported to the existing CFA bulky-waste landfill for disposal.

5.4 Contaminated Project Waste

Grubbed material, roots, bushes, fencing, posts, and other foreign matter was placed and compacted prior to placement of the consolidated soils layer. This waste is suspected to be contaminated since it came from within the soil-contamination area. Approximately 46 m^3 (60 yd^3) of this waste was buried under the SL-1 consolidated soils, and 15 m^3 (20 yd^3) buried under the BORAX-I consolidated soils.

5.5 Equipment Decontamination Water

To the largest extent practicable equipment was decontaminated using dry decontamination methods. If dry decontamination methods were not successful then wet methods were employed. A water truck was parked outside the exclusion zone and the pressure hose was used for decontamination. All decontamination water was dispersed to the soil contamination area within the exclusion zone. Subsequent RADCON surveys revealed no hot particles had been dispersed in the area used for washing. This method minimized the amount of waste generated.

5.6 Laboratory Samples

The laboratory sample waste consisted of 63, 16-oz squat jars of soil samples including two liquid rinsate blanks collected during the remediation activities at the SL-1 and BORAX-I sites. Forty-nine soil samples were collected from SL-1. Fourteen soil samples and two rinsate blanks were collected at

BORAX-I. The samples were collected in accordance with the FSP and analyzed at the LMITCO Radiation Measurements Laboratory. After sample analysis and completing hazardous waste determination forms, the unaltered samples were disposed beneath the remedial covers. The jars of material were opened and the contents disposed to the contaminated soil layer after which the empty jars were surveyed by RADCON and disposed as nonradioactive, non-CERCLA waste at the CFA Landfill.

5.7 Equipment Oil and Filters

The waste oil from equipment that had been in a soil contamination area was collected in either a 144 or 208-L (30 or 55-gal) drum for temporary storage pending sample results. Samples of the oil were counted/screened for radioactivity content by the Radiation Measurements Laboratory. After sample results were received and found to be nonradioactive, the oil was released to the Subcontractor for disposition. Air filters and oily rags were surveyed by RADCON prior to release for disposal by the Subcontractor. Since all the heavy equipment was leased, the oil, oil filters, air filters, and oily rags were taken offsite by the equipment vendor maintenance/service truck.

The waste oil, oil filters, air filters, etc., from equipment which had not been in the soil contamination area was not sampled or surveyed by RADCON. This waste was disposed offsite by the Subcontractor's equipment vendor service truck.

6. PREFINAL AND FINAL INSPECTION

The prefinal inspection for the SL-1/BORAX-I project was conducted on October 22, 1996 in accordance with a prefinal inspection checklist. The project had most items greater than 90% completed and the progress was accepted as satisfactory by the agencies.

The DOE and IDHW performed an inspection on April 23, 1997, after reseeding was completed. The final inspection was completed on May 8, 1997, when EPA did its inspection. Items 10 and 11, Appendix F were added to the checklist as a result of the April 23rd inspection.

By June 1997, all required vendor data had been submitted and the inspection items had been satisfactorily completed. The prefinal and final inspection checklists are included as Appendix F.

7. SUMMARY AND VERIFICATION OF WORK PERFORMED

The primary RD/RA work activities for the SL-1/BORAX-I engineered barriers project included:

- Excavation and consolidation of contaminated soil
- Verification that the excavated areas were cleaned up to meet the RAOs as outlined in the OUs 5-05 and 6-01 ROD
- Hauling/placing of engineered barrier layers over the burial sites
- Placement of monuments
- Installation of chain-link fences and warning signs around the sites
- Reseeding of disturbed areas.

7.1 Summary of Work Performed

The SL-1 burial ground and BORAX-I burial ground have been contained by capping with engineered barriers composed of natural materials as specified by the agency approved OU 5-05/6-01 RD/RA Work Plan. This included:

- Surrounding surface soils exceeding the activity concentrations corresponding to a human health excess cancer risk to an onsite resident of one in 10,000 were excavated and consolidated under the engineered barriers
- The engineered barriers will shield against penetrating radiation, discourage human and biotic intrusion, resist erosion, require low maintenance, and provide long-term performance and durability
- Access restrictions in the form of fences, warning signs, CERCLA signs, and permanent markers have been erected to prevent unauthorized entry into the burial grounds
- Disturbed areas have been recontoured and reseeded
- Written notification of the remedial action has been placed in the facility land use master plan
- Provision for long-term maintenance inspections and periodic review, to ensure that the remedy achieves the RAOs, have been included in the O&M Plan, Appendix G.

The field work began in July, 1996 and was completed in April, 1997 at a cost of $1,630,362. Due to the low levels of radioactivity at the surface of the burial sites and RADCON applied during the work, the remedial action was completed with no measurable above-background-level radiation exposure to the workers.

7.2 Verification of Work Performed

Verification of the work performed was documented throughout the duration of the project. The Parsons Infrastructure & Technology Group, Inc. (Parsons) CE and Subcontractor jobsite supervisor maintained daily force reports that detailed the work activities, quantities of fill material, number of personnel on site, schedule and equipment issues, and any other coordination items that needed to be addressed at the time. These daily force reports and plan of the day meeting report forms can be found in the project files. The Subcontractor was required by the contract specifications to perform inspections of the different phases of layer material placement. Inspections were performed to verify the work had been completed per the specifications by Subcontractor quality control and an independent engineering and testing firm. Vendor data was submitted and verified compliance.

In addition, asbuilt drawings were submitted for approval. These drawings verify the conformance to the specifications by detailing the contour elevations of the various layers. Field layer thickness measurements were also performed by the jobsite supervisor, a laborer and witnessed by the Parsons CE. The asbuilt drawings and layer thickness final measurements are included as Appendix A.

Project management and quality surveillances and assessments of construction activities were performed in accordance with the Quality Program Plan, PLN-125, quality level 3 as specified in the RD/RA Work Plan. Management assessments were an ongoing process documented by notation in the weekly progress reports located in the project files. Specific management assessments were performed monthly. An independent company performed an assessment (RD/RA audit) in August 1996. Sampling validation and quality control are discussed in Section 2.4.2.

8. CERTIFICATION THAT REMEDY IS OPERATIONAL AND FUNCTIONAL

This section is a certification that the remedy is operational and functional and meets the RAOs as set forth in the ROD following the implementation strategy specified in the agency approved RD/RA Work Plan (Table 8-1).

Table 8-1. Implementation strategies for RAOs.

Remedial Action Objectives	Remedial Action Objective Implementation
1. Inhibit exposure to radioactive material	• Consolidate contaminated soils under the barrier • Install a biotic barrier at SL-1 • Install a rip-rap layer • Install a security fence and signs around each barrier.
2. Inhibit ingestion of radioactive material	• Take precautions to prevent the generation of fugitive dust during construction • Consolidate contaminated soils under the barrier • Install a biotic barrier at SL-1 • Install a rip-rap layer • Install a fence to inhibit intrusion.
3. Inhibit inhalation of suspended radioactive materials	• Take precautions to prevent the generation of fugitive during construction • Consolidate contaminated soils under the barrier.
4. Inhibit degradation of the burial grounds	• Erect fences, permanent markers and signs limiting entry • Install a biotic barrier at SL-1 burial ground • Install a long-term barrier with rip-rap layer • Design to minimize erosion.
5. Inhibit adverse effects to resident species	• Consolidate contaminated soils under the barrier • Install a biotic barrier under a rip-rap layer • Install a security fence and signs around each barrier.

Performance standards as remedial action goals have been implemented to ensure that the cover system provides protection against direct exposure to the wastes at the two sites. The performance standards identified for the remedial action and the corresponding remedial remedy are listed in Table 8-2 below.

Table 8-2. Implementation of remedial action goals.

Remedial Action Goals	Goal Implementation
Installation of caps that are designed to remain in existence for at least 400 years at SL-1 and 320 years to BORAX-I to discourage any individual from inadvertently intruding into the buried waste or from contracting the waste at any time after active institutional controls over the disposal sites are removed up to the design life or the cap.	Installation of large angular boulders (rip-rap) over the burial sites.
Application of maintenance and surface monitoring programs for the containment systems capable of providing early warning of releases of radionuclides from the disposal site before they leave the site boundary.	Ongoing inspections in accordance with the O&M Plan, Appendix G.
Institution of restrictions limiting land use to industrial applications for at least 100 years.	Facility land use master plan has been updated to show these restrictions.
Elimination, to the extent practicable, of the need for ongoing active maintenance of the disposal sites following closure so that only surveillance, monitoring, or minor custodial care are required.	Construction of the engineered barriers using naturally occurring materials.
Placement of adequate cover to inhibit erosion by natural processes for the specified design lives of the caps.	Use of rip-rap to prevent wind and water erosion.
Incorporation of features to inhibit biotic intrusion into the waste disposal pits and trench at the SL-1 burial ground.	Construction of a pea gravel/cobble stone/pea gravel biotic barrier.

The inspection and maintenance of the cover system will be conducted concurrent with the radiological survey program. Implementation of the maintenance and survey programs will ensure protection of human health and the environment from any unacceptable risks. These programs will be implemented semi-annually during the first year and annually thereafter for the first five years following completion of the caps. The necessity for continued monitoring will then be reevaluated and defined as determined appropriate by the agencies during subsequent five-year reviews, as specified in the O&M Plan, Appendix G.

The above listed remedial action remedy is hereby certified to be operational and functional in accordance with the ROD RAOs and the implementation strategy specified in the RD/RA Work Plan.

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